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CONSIDERATION OF THE AR-85A VIEWER-COMPUTER FOR USE IN COMPUTER-AIDED INSTRUCTION IN IMAGE INTERPRETATION

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CONSIDERATION OF THE AR-85A VIEWER-COMPUTER FOR USE IN COMPUTER-AIDED INSTRUCTION IN IMAGE INTERPRETATION

The question has been raised as to the feasibility of utilizing the AR-85A viewer-computer as a vehicle for administering computer-assisted training in image interpretation. The AR-85A, which was designed to be used for mensuration and reporting functions, includes a limited computer capacity with associated limited input-output capabilities. When this capability is not being used for its principal functions, the possibility exists for using it as a tool for instruction, either in the school situation or for on-the-job training and proficiency maintenance in the field. The present analysis was concerned with determining if this capability may be utilized in a cost-effective manner for this instructional purpose.

THE AR-85A

The AR-85A consists of a motorized light table used in conjunction with a modified M-18 computer. The M-18 was originally designed as a gun direction computer but has been applied to the solution of photogrammetric problems and the production of interpretation reports 1/2/.

The components of the AR-85A are represented in Figure 1. Inputs may be made to the computer by a reticle on the light table, numeric keyboard, matrix, or tape reader. The reticle is positioned on the light table by means of a joystick to designate a particular point on the imagery being viewed, and this position may then be read into the computer. The matrix consists of an 8 x 8 configuration of indicator lights activated by the appropriate combination of pushbuttons arranged on the periphery of the matrix. These inputs may be used to designate the parameter being entered or the program or subroutine to be performed by the computer. During generation of a report, descriptors may be input via the keyboard using a numeric code.

The M-18 computer has a memory unit consisting of a magnetic disk with a capacity of 8,192 32-bit words. For operational use, the computational and other routines are pre-loaded onto the disk via a "signal data reproducer" unit which reads the program off paper tape. In addition, of the total of 64 channels on the disk, 4, 12, or 16 may be selected, via an internal switch, to be "hot", that is, subject to modification by data feeding via a tape reader located on the control

1/ Operator and Organizational Maintenance Manual, Console, Viewer-Computer, Imagery Interpretation, AR-85A, TM 11-5895-460-12, Washington, D. C.: Department of the Army, May 1967.
2/ Operator's Manual, Computer, Gun Direction, M18, TM 9-1220-221-10, Washington, D. C.: Department of the Army, September 1964.

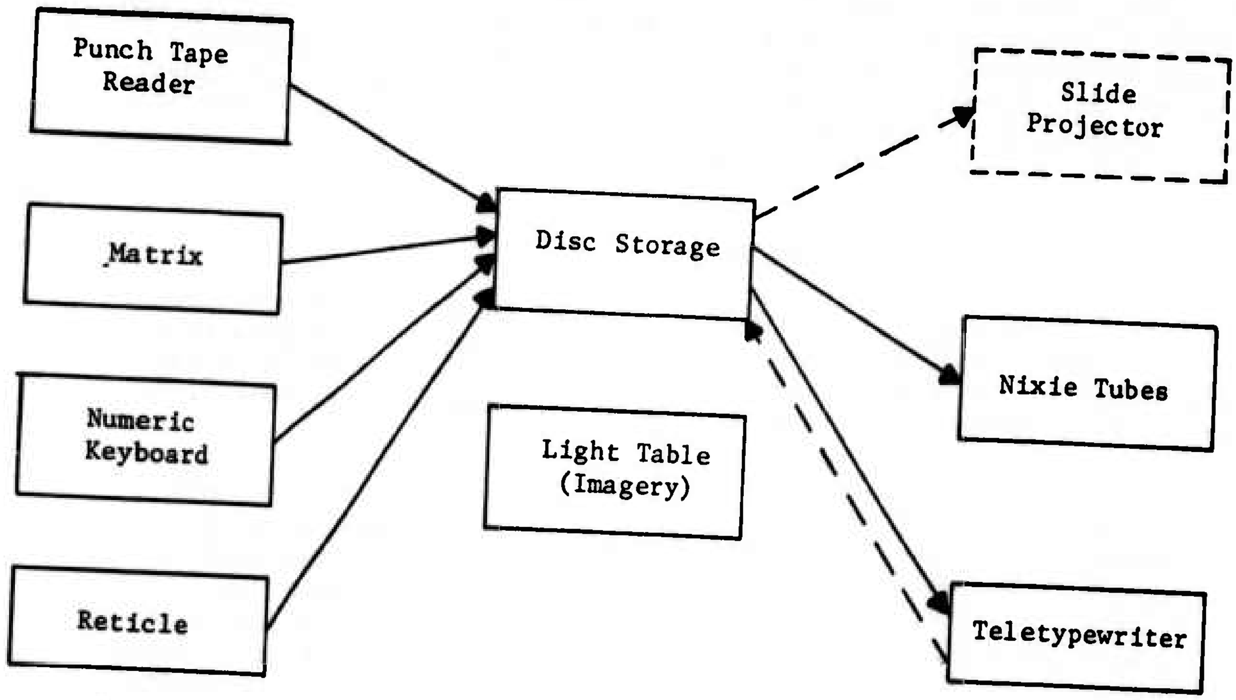

Figure 1. Schematic representation of AR-85A components (Dotted lines indicate possible additions)

panel. The numerical solutions to the computational problems are displayed on a row of Nixie[3] tubes or printed out on a teletypewriter. Reports may also be printed out on the teletypewriter.

FACTORS DETERMINING FEASIBILITY OF UTILIZATION

In determining the feasibility of using the AR-85A for instructional purposes, four interacting factors must be considered: 1) the instructional objective to be achieved, 2) the limitations of the computer and associated input-output capability, 3) the instructional strategy and materials required, and 4) the programming which will be required to present the instructional program. The feasibility and desirability of using the AR-85A depends on whether an appropriate cost-effective utilization can be developed within the limitations of the device. The interaction of the first two factors will therefore have the greatest impact in determining the feasibility of the suggested utilization. However, the other factors, which are more concerned with the actual development of a unit of instruction, must also be considered. For example, astute programming may permit an objective to be achieved despite the limited storage capacity of the computer. On the other hand, a particular instructional strategy may call for greater computer capacity than is available.

INSTRUCTIONAL OBJECTIVE

Any number of units of instruction could be written in a form amenable to CAI. A unit would have to be cast into a succession of frames or sub-units that could be presented under computer control, as has been done in organizing a programmed training course for infra-red interpretation.[4]

The initial determinant to be considered must be the instructional objective to be pursued. Will the unit of instruction be concerned with identification of a particular category of target, for example? Or will the objective be training in the characteristics of a particular area? The training objective must be considered in interaction with the capabilities of the device and with the attendant requirements for presentation of various types of material, pictorial and textual. An important consideration in the selection of the mode of

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3/ Commercial designations are included in the interest of complete description only and do not constitute indorsement by BESRL or by the Army.
4/ Harrison, P. C., W. Dick, and S. S. Palette. Design, development, and evaluation of a programmed instruction course for infrared image interpreters (U). RADC-TR67-493, Rome Air Development Center. Technical Report 67-493. June 1968. CONFIDENTIAL.

presentation will be the amount of textual material to be presented. The AR-85A as it stands is limited in the degree to which textual material can be presented. Textual material may be printed out by the teletypewriter, or presented on the film on the light table. The subject could be instructed to turn to a particular frame of imagery containing textual material. The possibility also exists of using a slide projector and having the computer address a particular slide, or directing the student to turn to a particular slide. These procedures would materially increase the amount of textual material that could be presented.

Associated with the limited memory capacity of the AR-85A, which would probably require augmentation with a slide projection device, is the fact that the teletypewriter now can be used only as an output device and cannot be used by the trainee to make an alphabetic input. Such input could be accomplished by the addition of an interface device, an addition which, once again, would entail requirements for more capacity.

The particular instructional objective will dictate the mix of textual material and imagery or pictorial material that must be presented. This mix will in turn dictate the feasibility of presenting the required materials via light table and teletypewriter on the AR-85A as it stands. If augmentation by slide projection is not to be used, presentation of textual information will be limited, and there would be less flexibility in interacting with the instructional material. Such restrictions could result in limiting the instructional objective to be attempted. Indeed, the degree of flexibility attained through augmenting devices may determine whether the AR-85A should be used for this type of instruction.

If the instructional objectives are to deal primarily with imagery, the AR-85A could be more easily adapted to the purpose, since the computational routines for which the AR-85A is now used deal with imagery. The student could be given a series of practical exercises in various identification techniques. He could be asked to detect or identify all targets on a particular frame by giving the location of each. Location could be indicated by use of the reticle or by the matrix or the numeric keyboard using a grid system. The student could indicate his identification by use of the matrix on which would be printed the target list or by use of the numeric keyboard as in current reporting routines. He could also be asked to make a report on a frame of imagery as is now done. Stored within the computer memory would be the "school solution" for that frame. Response would be compared by the computer with the stored solution, and feedback given by the typewriter or possibly by illumination of one of the segments of the matrix.

APPROPRIATE USE OF THE COMPUTER

As indicated previously, the problem is to develop an appropriate cost-effective utilization within the limitations of the device. The aim would be to avoid using the computer for procedures that can be conducted just as effectively and perhaps more economically by other means. For example, small frames of information can be presented to the subject in fixed sequence and the subject queried about each piece of information. He then compares his answer with the correct answer on the next page and thus gains immediate knowledge as to his comprehension of the unit of instruction. Such instruction does not have to be done on a computer, with the attendant need to write a program to control the computer.

With reference to imagery the student could be asked to annotate a frame of imagery, either directly on the imagery or on an overlay. After he has completed his annotations, an overlay showing the school solution could be given him so that he can determine how his annotations compare to the proper interpretation. The only advantage to using a computer as a "page-turner" in such a program is that it prevents the student from looking at the solution before he has committed himself to a solution.

Numerous applications of computer-assisted instruction have been developed. CAI is being extensively studied and used for various educational purposes. The interaction of a computer with a student can be a potent influence. With a computer in the loop, the sequence of instruction may be modified in keeping with the responses of the student. A degree of individualized instruction is possible that might not be feasible otherwise. The student can progress at his own pace and be exposed to material in a fashion to enhance the learning process. He may be exposed to as much or as little material at as fast or as slow a pace as may be dictated by his own performance. The capability of a computer to adapt the presentation of instructional materials to the student can be most effective. Indeed, the possibility of using such computer capability within an advanced image interpretation facility has already been recognized in previous BESRL experimentation 5/ 6/. However, the computer used in these experiments had a core memory with capacity for 32,000 words as compared to the 8,192 in the M-18. Most studies concerned with CAI have utilized computer capabilities much in excess of that of the M-18 7/.

5/ Root, R. T., P. D. Gallagher, and R. Sadacca. Maintaining interpreter proficiency in a computerized facility: Programming and feedback method. Arlington, Virginia: U.S. Army Behavior & Systems Research Laboratory, Technical Research Note 209, April 1969.

6/ Root, R. T., A. E. Brahosky, T. E. Ray, and M. A. Narva. A study of the design and utilization of an infrared data base for an advanced image interpretation facility (U). Arlington, Virginia: U.S. Army Behavior & Systems Research Laboratory, Technical Research Note (CONFIDENTIAL) in preparation.

7/ Narva, M. A. Application of computers to training in image interpretation. In Proceedings, Symposium, Application of Computers to Training, National Security Industrial Association, Washington, D. C., February 10-11, 1970.

The capabilities of the M-18 may be augmented by addition of a slide projector. Also, it is possible to couple two or more M-18's together to provide greater storage capacity. However, more complex programming would be called for if the stations were to time-share the memory. If the number of computers available is limited, the coupling would reduce by half the number of students that could be trained at any one time.

INSTRUCTIONAL STRATEGY AND MATERIALS

The essence of computer-assisted instruction is the interaction of the student with the computer. The computer must operate on the responses of the student in order to determine: 1) if the instructional sequence is to be changed, and 2) what change is to be made. For example, if it has been determined that the subject has reached a certain level of proficiency at a certain point in the program or at completion of a certain unit of instruction, he may be advanced to a subsequent step or unit; if he has not reached the desired level, he is required to take additional instruction on a particular aspect of instruction or in a particular unit. In addition to determining where the next presentation is to be drawn from, the computer also may determine the content. The student may be told why his preceding answer was incorrect or he may not. He may be required to go through a set of presentations rather than a single presentation. Obviously, the more alternatives involved the more complex the program and the greater the required storage capacity of the computer.

In using a computer for image interpretation training, the complexity of the feedback would be determined both by the instructional strategy being followed and the capability of the computer. Suppose a student is asked to search a frame of imagery and report all targets and their locations using the joystick and the target matrix. The computer could indicate for each detection or identification the correct answer for that location (including "no target") which is stored in memory. It would then be up to the student to compare his identification with the correct answer. The computer might also be asked to print out the student's identification together with the correct identification. This strategy tells the student whether his identification is correct or incorrect and, if it is incorrect, what the correct answer is. A different strategy would have the computer give some additional information to the student--some prompting or guidance as to why he had made an incorrect answer. For this strategy the computer would have to have in storage appropriate feedback for the various answers a student might give, as was done in the "response-sensitive" mode in one of the previous BESRL studies[8/]. For this procedure, the material must be so designed that appropriate feedback may be given. For example, in target detection, factors which may cause an omission or commission error or a misidentification must be determined and stored in the computer for subsequent feedback as appropriate.

8/ Root, R. T., P. D. Gallagher, and R. Sadacca. Maintaining interpreter proficiency in a computerized facility: Programming and feedback method. Arlington, Virginia: U.S. Army Behavior & Systems Research Laboratory, Technical Research Note 209, April 1969.

In the example just given, immediate feedback could be given as the student makes each identification or after a series of identifications. The latter approach would require the computer to hold the feedback to be given for each identification in memory until the end of the exercise. More memory and more programming would be required than for immediate feedback. However, as noted previously, feedback over a series of identifications could be provided by giving the subject an overlay with the correct solution. Indeed, it appears that the computer would be more advantageous for immediate feedback following each identification. It seems impracticable to provide such immediate feedback with an overlay which might give the student a tip as to the presence of other targets yet to be identified. Of course, frames could be limited to one target each, posing an artificial restriction on the instructional materials.

Also, the nature of the instructional strategy and associated feedback will interact with the instructional material. A frame showing one vehicle at large scale, as might be used in identification training, may be used quite differently than a frame of small-scale imagery on which there may be several targets. Once a particular instructional objective has been chosen, the materials must be developed and cast into such form as to complement the limited capabilities of the AR-85A and the programming that is possible. For example, an instructional unit on the identification of U.S. tanks was formulated for use in a previous study[9/]. A sequence of frames of text and pictorial materials was assembled--a tedious, time-consuming process requiring also subject matter expertise.

PROGRAMMING

Even the simplest program can prove difficult to develop. Programming personnel must be utilized and time allowed for "debugging". On the other hand, limitations of the computer capacity can be compensated to some degree by ingenuity in programming.

It has been learned that, by overriding a lockout feature, all 64 channels of the disk memory can be accessed by paper tape from the tape reader on the control panel. While this procedure may not be feasible in the operational setting, it does expand the possibilities for instructional use. Portions of the memory may be revised or refreshed by inputs from the punched tape as the student proceeds through the program. In essence, portions of the program are retained on the tape and then entered into the appropriate portion of the disk memory at the appropriate time. The tape could be synchronized with the progress of the student through the frames of instructional material. While this procedure does expand the computer capabilities, it calls for more

9/ Root, R. T., P. D. Gallagher, and R. Sadacca. Maintaining interpreter proficiency in a computerized facility: Programming and feedback method. Arlington, Virginia: U.S. Army Behavior & Systems Research Laboratory, Technical Research Note 209, April 1969.

complex programming. The paper tape reader can be stopped and started under program control. To learn the language used to program the M-18, programmers must take a course at Frankford Arsenal. With any program, a constant iterative process of correction is necessary. In order to develop the program properly, therefore, ready access to an AR-85A or to an M-18 (if the reticle position readout feature is not required) would be essential, and it would be desirable that the equipment be located in BESRL.

EVALUATION AND IMPLEMENTATION OF THE PROGRAM

Once an initial unit of instruction has been assembled (if this is deemed feasible), the unit must be evaluated. Evaluation would involve having a number of student interpreters (or students with equivalent backgrounds) run through the unit of instruction to ascertain if exposure to the unit has a significant effect on their performance. In developing the unit, segments should also be tried out on students to determine where improvements can be made. Necessity for tryout and evaluation is another reason for having the hardware available at BESRL, if such a unit is to be developed.

Utilization of such units of instruction in the school setting must take into account the fact that the number of stations available are limited and any one class must be divided at any one time between conventional instruction and any CAI with the AR-85A, or the CAI unit must be programmed to fit in at different times for individual students. Also, use of the AR-85A could be fitted into hours other than those scheduled for classroom instruction.

SUMMARY

Various factors that must be considered in determining the feasibility of using the AR-85A for instructional purposes have been discussed. The memory capacity of 8,192 words is small and would limit the instructional objectives to be attempted. The most promising utilization would appear to be in identification training and the presentation of feedback to the student. Small units of instruction to be incorporated at various points in the program of the individual student may be feasible.

The iterative nature of the development of such a program has been indicated, along with the need to have the computer at hand during the development.

The only concrete way to determine the feasibility of formulating an instructional program using the AR-85A appears to be to develop and try out such a program, with the required commitment of time and personnel and continual access to the computer. Initially, a demonstration of the various functions which may be performed by the computer is planned. If these various functions can be satisfactorily performed, they may be combined into a sample unit of instruction.